AE451: Experiment # 2 data analysis

Hot-wire Calibration data analysis:

King's law:- $$E^2 = A + BU^n \quad \text{--- (1)}$$

$E \Rightarrow$ hot-wire output (volt)

$U \Rightarrow$ manometer reading (m/s)

→ When $U = 0$ m/s ⇒ NO wind reading

$E_0^2 = A$; $E_0 \Rightarrow E$ at (zero m/s).

$$\Rightarrow \boxed{A = E_0^2}$$

$$\Rightarrow \quad E^2 - E_0^2 = BU^n.$$

→ take log both side.

$$\log(E^2 - E_0^2) = \log B + n \log U \quad \text{--- (2)}$$

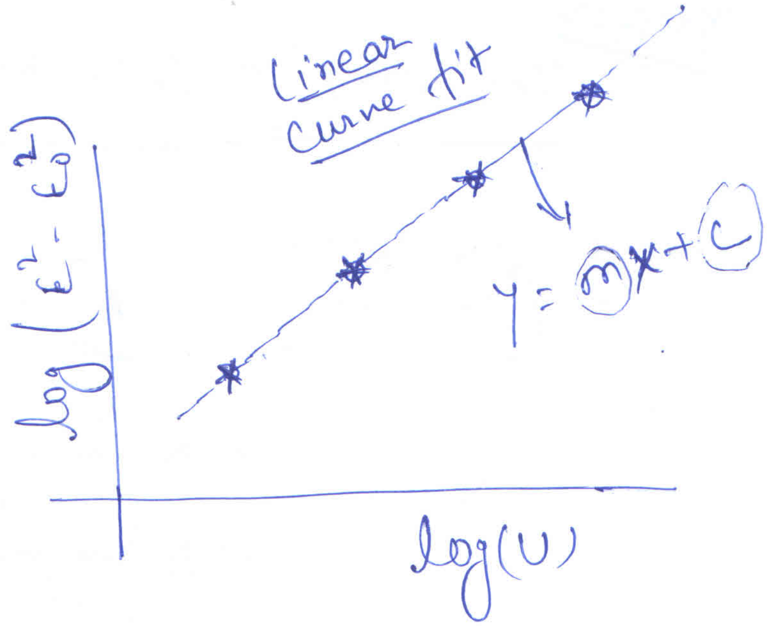
In the form of $\boxed{Y = mx + c}$

$$\underbrace{\log(E^2 - E_0^2)}_{Y} = \underbrace{n}_{m} \underbrace{\log U}_{X} + \underbrace{\log B}_{C}$$

→ Now, plot $\left[\log(E^2 - E_0^2)\right]$ Vs $\left[\log U\right]$

→ Do a linear curve fit.

→ find the slope 'm' and Intercept 'c'.



$$y = mx + c$$

$$\log(E^2 - E_0^2) = \underline{n} \log U + \log B$$

$$\Rightarrow \boxed{\underline{n} = \underline{\text{slope}} = m} \text{ — (A)}$$

$$c = \log B \Rightarrow \boxed{B = e^{c}} \text{ — (B)}$$

$$\boxed{A = E_0^2} \text{ — (C)}$$

<u>Now</u> to convert hotwire ~~...~~ voltage to velocity using A, B and n.

$$E^2 = A + BU^n$$

$$\Rightarrow \boxed{U = \left(\frac{E^2 - A}{B}\right)^{1/n}}$$

Velocity profile Data analysis

→ Using the Calibration coefficients, convert all the time series hot-wire data (in volt) into velocity (m/s) signal.

→ For each y-location, calculate the mean and rms (standard deviation) of the hotwire velocity data (in m/s).

→ plot $\frac{\bar{U}}{U_0}$ and $\frac{U_{rms}}{U_0}$ vs y/d for all the cases.

where, $\bar{U}$ ⇒ Hot-wire mean velocity
U_{rms} ⇒ Hot-wir r.m.s velocity
U_0 ⇒ free stream velocity.

→ U_0 can be taken as the mean velocity of the hot wire, when it is outside the wake (at $y = 4d$). Otherwise, manometer reading can also be taken as free stream velocity.